IOP
SCIENCE 16–26

A. PROGRAM RATIONALE AND PHILOSOPHY

RATIONALE

In recognition that the needs of both the individual and society may best be served through school experiences designed to meet student needs and abilities, the *Secondary Education in Alberta* policy statement, June 1985, directs that a program be developed for students who have experienced difficulty learning. This program, beginning in Grade 8, is known as the Integrated Occupational Program (IOP) and articulates with a similar program in the senior high school. The policy states that:

> . . . the goals of secondary schools are to assist students to . . . become aware of the expectations, and be prepared for the opportunities of the workplace—expectations that will be faced as employees or employers; expectations that will be faced as entrepreneurs or volunteers . . . (p. 13)

The policy also states the value of community partnerships in the educational process:

> Opportunities must be provided to involve the community in secondary education programs and to recognize and support learning experiences which take place outside of schools. (p. 8)

In addition, the policy statement directs that:

> The Certificate of Achievement will be awarded to those students who, because of their abilities and needs, have taken the Integrated Occupational Program. The Certificate will recognize their achievement in that program. (p. 23)

The Integrated Occupational Program is designed to enable students to:

- become responsible members of society
- develop entry-level vocational abilities
- recognize the need for lifelong learning.

The Integrated Occupational Science Program provides a two-course sequence in science known as Science 16–26. Science 16 allows students to meet the credit requirements of the Certificate of Achievement. Science 26 allows students to develop further their knowledge and skills in science, and facilitates transfer to the General High School Diploma Program.

The Science 16–26 program provides for the development of essential concepts, skills and attitudes in science that will enable students to function successfully in the home, classroom, workplace and community. The program is activity-based, and addresses the need for students to be able to transfer and apply specific scientific concepts and skills to more generalized situations in everyday life and the world of work. This approach is intended to foster an appreciation of science for its usefulness and relevance, and thus motivate students to participate in the learning process.

As science and technology affect our lives in so many ways, it is necessary for students to appreciate and understand the dynamic relationships that exist among science, technology and society. Students need to understand how science is used in technology, and how technology affects the quality of our life and the health of our planet. Students also need to understand the potential value of technology as well as problems that may arise from its use. Societal issues involving science and technology have been integrated throughout this science program. Community partnerships provide opportunities for students to become involved in the community by way of meaningful activity linked to the science program.

Students are often unaware of strategies they may generate and employ to become more efficient in their cognitive functioning. Evidence supports, however, that students with learning difficulties can perform strategically, if taught to do so. Thinking strategies that foster effective behaviours in planning, organizing and self-monitoring are emphasized throughout the program, and provide students with a systematic and logical approach to dealing with a variety of phenomena encountered in their environment. As students learn to understand and control the outcome of tasks demanded of them, confidence in taking risks and accepting challenges will further their ability to solve problems and make informed decisions in everyday life.

Prescribed content within Science 16 and 26 reflects an emphasis on life skills, and has been determined on the basis of the abilities and needs of students for whom the courses were designed. Nevertheless, the philosophy, goals and directions established in the Integrated Occupational Science Program are consistent with those of other regular program science courses. This continuity will assist students in their transition from a regular program to the IOP, and from the IOP back to a regular program.

PHILOSOPHY

The need to develop programs for exceptional students is based on a fundamental belief about children, as expressed in the government's *Secondary Education in Alberta* policy statement, June 1985 that there should be: ". . . a respect for the unique nature and worth of each individual." (p. 7)

The Integrated Occupational Program rests on a number of additional beliefs and assumptions about the way children learn, the overall potential of these children and their learning needs in relation to societal demands. These beliefs and assumptions have a tremendous impact on program goals, design and implementation.

There are patterns and predictability to children's learning. However, each student's learning preference and pace is unique, reflecting past experiences. The Integrated Occupational Program is designed to address these differences. Though seen as "exceptional" in their learning needs, these children nonetheless fall within the normal range of learning potential; thus, every effort must be made to offer experiences that provide equitable opportunities to participate in all aspects of life. Inherent in the Integrated Occupational Program is an overriding commitment to prepare students for meaningful participation in our democratic society.

The Integrated Occupational Science Program focuses first and foremost on the needs of the learner. As attitude and self-esteem have powerful influences over learning, the program must foster within each student a positive self-concept and a positive attitude toward learning. The concepts, skills and attitudes addressed within the program must:

- provide meaningful and relevant learning experiences
- be appropriate to student ability
- provide for student success
- enable students to understand and function effectively in their personal environment.

Students vary in the ways they receive, process, recall, apply and communicate information. Each student has a preferred way of approaching learning tasks. Instructional planning should include careful assessment of each student's developmental characteristics, knowledge, skills and preferred way of learning. In order to ensure that individual student needs are being met, instructional plans may often need to be adjusted or modified.

Although students are at various stages of cognitive development, most will continue to use concrete operational thinking. Students will depend upon personal experience and personalized content to link new ideas with prior knowledge. As the process of analysis must be based on tangible experience, learning activities should begin at the concrete level. High emphasis should be placed on experiential learning involving first-hand investigation. An experiential approach will enable students to relate what they are learning to past experience. While concepts and skills cannot be developed in the absence of supporting facts, the knowledge component of science should not be over-emphasized.

Strategies that will assist the learner in progressing from the concrete level of thinking to more abstract thought processes are provided in the program of studies/curriculum guide and corresponding teacher resource manual, available for each IOP course from the Learning Resources Distributing Centre.

An integrated approach suggests the linking together of various scientific skills and strategies into meaningful investigations and activities. Many opportunities are provided for instruction through "thematic study", through the integration of skills "across the curriculum", and through the application of skills to "real-life" situations. This approach adds a motivational dimension to the program, and provides students with direct assistance in transferring specific skills to more generalized situations. Relevancy to daily living and future employment is emphasized throughout the program.

It is intended that the content and process of the Science 16–26 course sequence provide a student-centred, personal and practical approach to science. A program with these emphases will ensure student success in developing concepts, skills and attitudes that are requisite to responsible participation in the home, classroom, workplace and community.

B. GENERAL LEARNER EXPECTATIONS

ntegrated Occupational Science Program is ied to assist students in developing and aining:

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nstructive relationships with others

ositive attitudes toward science and lifelong arning.

n the Science 16–26 course sequence, *nts will be expected to*:

evelop essential concepts, skills and attitudes out science that are required for responsible rticipation in the home, the school, the orkplace and the community

pply scientific concepts and skills to daily fe and occupational situations that are perienced both inside and outside the ience classroom

evelop critical and creative thinking skills, d apply these skills to a variety of practical tuations through processes of scientific quiry, problem solving and decision making

evelop appropriate concepts, skills and titudes in the responsible use of science and chnology

evelop communication skills that are used hen gathering, interpreting and applying ientific knowledge.

RNING DOMAINS

ıdes

nts will be encouraged to develop attitudes iated with the successful study and practice ience; e.g., curiosity, respect for evidence, ation to tolerate uncertainty, open-edness, critical-mindedness, perseverance, vity and inventiveness, appreciation for work, confidence in personal ability, respect curacy and precision, concern for safety.

Additionally, students will be encouraged to develop the feelings, opinions, beliefs and appreciations that individuals have formed as a result of interacting with various aspects of the scientific enterprise; e.g., a positive attitude toward mathematical and scientific process skills, need for problem-solving skills, respect for historical development, appreciation of ethical dilemmas that may arise from the application of scientific and/or technological developments, sensitivity to the living and non-living environment.

Skills

The skills identified below serve to guide the design of learning experiences and the construction of assessment schemes. Skills are not intended to be developed separately or sequentially, but rather, concurrently with attitude and concept components.

Students will be expected to demonstrate an ability to:

- distinguish between relevant and irrelevant information; e.g., define problems/identify issues, set goals by establishing purpose and direction, formulate questions to guide research/inquiry, identify variables
- gather information or data; e.g., use an experimental design or research plan, make qualitative and quantitative observations, effectively use apparatus and equipment
- arrange or structure information so it can be readily understood or presented; e.g., classify, order and identify patterns/trends, draw charts/graphs/diagrams, express data in the form of a simple mathematical relationship
- analyze data or information; e.g., identify main ideas/attributes/components, identify patterns and relationships, identify errors, detect bias

- make connections among new ideas and prior knowledge, and generate information beyond that which is given; e.g., explain and elaborate; predict and hypothesize; infer and generalize from the data; design experiments or devise a plan for research; identify further problems, questions and issues to be investigated

- integrate new information with prior knowledge; e.g., summarize and communicate findings, develop consensus within a group, make a decision or develop a conclusion/solution

- assess the logic and quality of ideas and information; e.g., consider consequences, establish criteria to judge data, assess a design or approach taken to inquiry, problem solving or decision making, assess the achievement of goals set.

Concepts

Students will be expected to demonstrate an operational understanding of ideas fundamental to science, including:

- matter has structure and composition, and there is an interaction among its components

- matter and energy are conserved in reaction and living systems

- living organisms are interdependent with one another and with their environment

- life forms exhibit uniquity, diversity and a changing nature

- biological, chemical and physical systems are in a dynamic state where opposing forces and influences tend to balance each other.

PROGRAM EMPHASES

Nature of Science

An emphasis on the nature of science and the inquiry process will enable students to understand the ways in which scientific knowledge is gathered, as well as use this knowledge in conducting investigations of their own.

Students will be expected to demonstrate an understanding that:

- science is a disciplined way to develop explanations for the events and objects of the natural world

- science is comprised not only of an accumulated body of knowledge, but also of the processes by which that knowledge is developed

- empirical evidence plays an important role in the development of scientific knowledge

- physical laws and conceptual inventions that are theoretical and tentative in nature attempt to explain the universe

- proposed theories may be supported, modified or falsified by experimental evidence

- scientific knowledge is cumulative and subject to change.

Science and Technology

An emphasis on science and technology will enable students to understand the interaction between science and technology, and how science and technology may contribute to the solution of practical problems in everyday life.

Students will be expected to demonstrate an understanding that:

- technology facilitates the solving of practical problems

- technological development includes both products and processes

- the functioning of products and processes may be explained using scientific knowledge

- science can be used to advance technology, and technology can be used to advance science

- existing and emerging technologies have application in many everyday and work-related situations

- scientific knowledge and technology have limitations.

Science, Technology and Societal Issues

An emphasis on science, technology and societal issues will enable students to understand interactions that occur among science, technology and society, and how science and technology influence and are influenced by societal issues.

Students will be expected to demonstrate an understanding that:

- science and technology have impact on our lifestyle, occupational choice, environment and welfare
- technological products and processes develop in response to societal needs and wants
- economic, political and ethical perspectives often interact with science and technology and exert significant influence on each
- often the products of science and technology are accepted and used by society before the full extent of benefits/problems resulting from their use can be fully known
- scientific, technological and societal aspects of an issue help to inform the societal decision-making process
- compromises are often needed in order to arrive at workable solutions involving science and technology in society.

Specific Learner Expectations

Specific learner expectations (learning objectives) have been identified for Science 16 and Science 26 in the Statement of Content, which follows.

C. STATEMENT OF CONTENT

PROGRAM FRAMEWORK

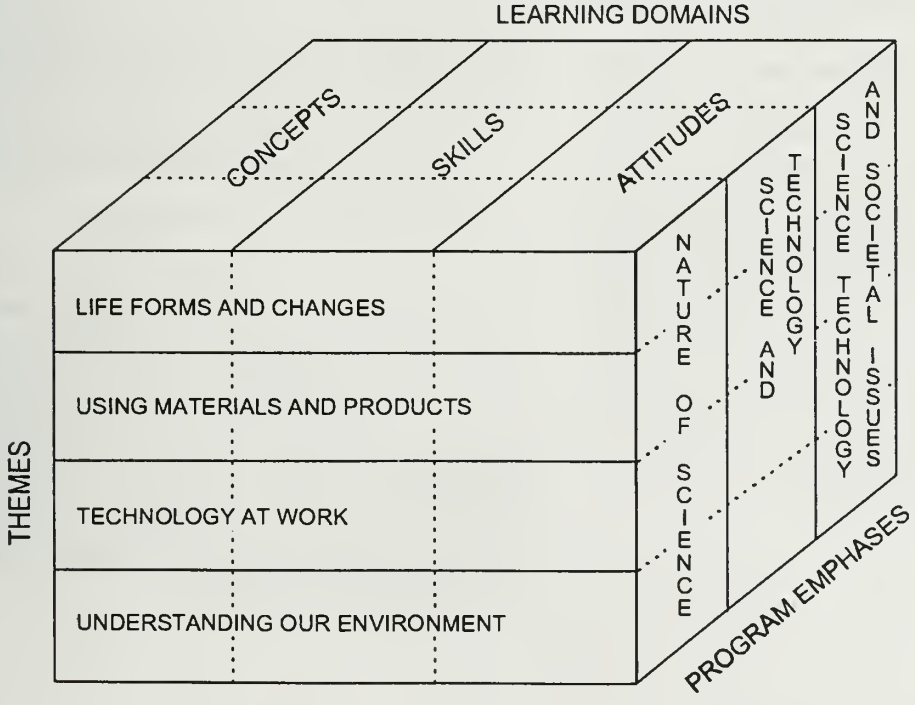
The framework for the Integrated Occupational Science Program, depicted in the model below, illustrates an integration of program dimensions. Three dimensions that provide a basis for program planning are represented in the model.

- The LEARNING DOMAINS, represented on the upper face of the model, provide a structure for the science program and include the concepts, skills and attitudes that students will be expected to develop. Prescribed content within each of the learning domains has been selected on the basis of frequent task demands placed on students in daily life and work-related situations, and represents a consolidation and extension of concepts, skills and attitudes included in the Integrated Occupational Science Program for Grades 8 and 9.

- The PROGRAM EMPHASES, represented on the right face of the model, take into account both the content and intent of science education, and foster the development of knowledge and behaviours that will enable students to interpret and process information in their environment relative to the demands of everyday life. Learning activities that foster the development of knowledge and behaviours related to each program emphasis should be provided in concert with activities designed to develop prescribed content within the learning domains.

- The THEMES provide situational and concrete learning experiences where concepts, skills and attitudes are linked with appropriate program emphases. The themes are placed on the front face of the model to highlight their importance in planning an integrated program. Four themes that address prescribed components within Science 16 and Science 26 are provided in the teacher resource manual, available from the Learning Resources Distributing Centre.

INTEGRATED OCCUPATIONAL SCIENCE 16–26 PROGRAM



CREDIT ALLOCATION

Science 16 and 26 are each 3-credit courses. Schools are encouraged to provide more instructional time than would normally be allocated for a 3-credit course, if this will help to ensure student success.

Certificate of Achievement

In order to qualify for a Certificate of Achievement, a student is required to take a minimum of 27 credits in specified core courses and 40 credits in occupational courses throughout the senior high program. An additional 13 credits, for a total of 80 credits, are required to complete the Certificate of Achievement. Some or all of these unspecified credits may be obtained through completion of additional IOP courses.

COMMUNITY PARTNERSHIPS

Students need to recognize the relevance of scientific knowledge in daily life experiences within the home, community and work environments. Within this context, students will be expected to demonstrate competencies that will enable them to:

- apply scientific concepts and skills to practical situations
- set goals, solve problems and make informed decisions
- prepare for a chosen occupation or career.

Community partnerships that are community-based learning experiences will foster an appreciation of science for its usefulness and relevance, and will assist students to transfer specific concepts and skills to more generalized situations in everyday life and the world of work. Community partnerships include in-school visits, demonstrations, talks, etc., given by community members; and teacher/student observations, job shadowing, work study and work experience activities within the community.

CURRICULAR INTEGRATION

Teachers have traditionally tended to integrate concepts, skills and attitudes from other subject areas into their teaching specialty; however, this tendency has generally been incidental rather than by curricular and instructional design. In contrast, the Integrated Occupational Program is designed specifically to integrate related concepts, skills and attitudes across the curriculum. In addition, teachers in the program are encouraged to adopt integrated planning and teaching strategies.

Suggestions for relating prescribed content within Science 16 and 26 to daily life skills and applications in other subject areas across the curriculum are provided in the program of studies/curriculum guide and teacher resource manual.

REQUIRED AND ELECTIVE COMPONENTS

The required component of the Science 16–26 program includes the concepts, skills and attitudes that all students must acquire. The learner expectations identified within this document comprise the required component of the Science 16–26 course sequence.

The required component of Science 16–26 has been integrated into four themes at each level:

- Life Forms and Changes
- Using Materials and Products
- Technology at Work
- Understanding Our Environment.

These themes are developed in the teacher resource manual, and include a variety of student activities intended to provide suggestions, models and strategies. Although using these themes will ensure coverage of the required component, teachers are encouraged to add, delete and alter activities to meet the abilities, needs and interests of students.

The elective component of the Science 16–26 program permits the teacher to:

- extend or expand upon topics, thus embedding additional concepts, skills and attitudes considered appropriate to student interest and need
- enrich the program by introducing new concepts and activities considered relevant to the student and the local community
- remediate or reinforce concepts, skills and attitudes within the required component.

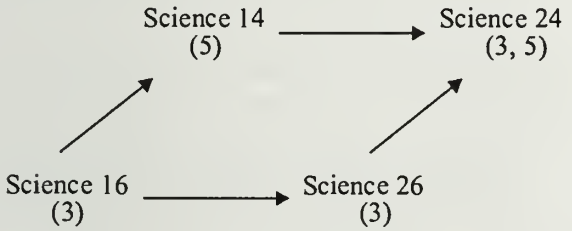
Students' abilities, interests and needs will largely determine how the elective component will be used. Teachers should assess student performance on an ongoing basis, and use the elective component of each course to provide individual students with remedial and/or enrichment activities.

Instructional time for the Science 16–26 program should be apportioned:

- 80% Required
- 20% Elective.

PROGRAM SEQUENCES AND TRANSFER POINTS

Students must acquire a minimum of 3 credits in science in order to obtain a Certificate of Achievement. Science 16 will allow students to meet this credit requirement. Science 26 allows students to develop their knowledge and skills in science more fully, and facilitates transfer to the General High School Diploma Program. Program sequences, credits and recommended transfer points are illustrated below.



Students who transfer to the regular program must acquire a minimum of 8 credits in science (including Science 24 for at least 3 credits) in order to obtain a General High School Diploma.

Additional information about transfer routes between the Integrated Occupational Program and the General High School Diploma Program is provided in the current *Guide to Education: Senior High School Handbook.*

SPECIFIC LEARNER EXPECTATIONS

Specific learner expectations for the Science 16–26 course sequence are provided on the pages that follow. Learner expectations have been clustered into four themes that provide situational and concrete learning experiences at each level.

The specific learner expectations that follow comprise the required component of each science course. Prescribed concepts, skills and attitudes should be appropriately clustered and applied to progressively difficult and/or age-appropriate situations as students advance through senior high school. Teachers are encouraged to organize for instruction in ways that are consistent with the abilities, interests and needs of students, using relevant sections of the program of studies/curriculum guide and teacher resource manual, locally developed themes, or a combination of approaches.

Prescribed content for the Science 16–26 course sequence is developmental through each level. Science 26 provides opportunities for students to reinforce and refine attitudes and skills developed in Science 16 through more extensive applications, and prescribes new concepts within each of four thematic areas of study. In cases where specific learner expectations are repeated in Science 16 and 26, it is expected that teachers will help students to increase in proficiency from grade to grade even though varying levels of proficiency have not been specified.

LIFE FORMS AND CHANGES

This theme will assist students to develop strategies for acquiring and maintaining healthful lifestyles. Students will develop an understanding of the implications of various technological and societal factors for health and fitness, and will assess the appropriateness of their own decisions in relation to health and fitness.

In Science 16 (Systems of the Human Body), students will examine critical life functions and the body systems that perform these functions. In Science 26 (Personal Health and Lifestyle), students will apply previously developed knowledge of human body systems as they consider the effects of various lifestyle factors on biological processes.

Specific learner expectations listed below are developmental through Science 16 and 26, and should be applied to progressively difficult and/or age-appropriate situations as students advance through senior high school. Learner expectations that extend across columns reflect the continuous process of attitude and skill development.

Specific Learner Expectations

Science 16	Science 26
Attitudes *The student will be expected to:*	**Attitudes** *The student will be expected to:*
• appreciate functional relationships that exist among systems of the human body	• appreciate the intricate workings and balance within the human body
• appreciate the contributions of science and technology to human health	
• value knowledge gained for its usefulness on a personal level	• value knowledge gained for its general application to all living things
• appreciate the need for informed decision making at a personal level	• appreciate the need for informed decision making at both personal and societal levels
• appreciate that ethical dilemmas may arise from the application of scientific research and/or medical technologies	
• begin to develop responsible attitudes toward personal health through nutrition, exercise, safety and lifestyle.	• display responsible attitudes toward personal health through nutrition, exercise, safety and lifestyle.
Skills *The student will be expected to demonstrate an ability to:*	**Skills** *The student will be expected to demonstrate an ability to:*
• collect data related to critical life functions and body systems through observation, interview and/or research	• collect data related to personal health, fitness and lifestyle factors by using a variety of information-gathering techniques
• conduct an investigation that illustrates the use of a technology (e.g., stethoscope) in monitoring the functions performed by a body system	• plan, design and conduct and investigation to examine induced variations in the functioning of a body system
• use appropriate monitoring technologies to collect personal data regarding body systems and vital signs	• select and use appropriate technological processes, instruments and/or products to collect personal data regarding health and fitness

Science 16

Skills (continued)

- analyze and assess personal health factors by identifying relationships and considering consequences
- draw conclusions regarding factors that may influence the healthful functioning of body systems
- apply the results of investigation to personal situation, identifying appropriate strategies for monitoring and maintaining personal health.

Concepts

The student will be expected to demonstrate an understanding that:

- the human body is a product of a number of body systems working together to perform critical life functions
  - identify critical life functions and the body systems that perform them
  - describe how each system contributes to the health of the individual
- each body system has specific structures that enable it to perform a critical life function
  - identify individual structures associated with the digestive system and circulatory system
  - describe the functions associated with each structure of the digestive system and circulatory system
- functional relationships among systems of the human body are critical to life
  - illustrate, through example, how a body system adjusts to changes in other body systems in order to maintain balance; e.g., blood sugar, breathing and heart rate
  - illustrate, through example, what happens when disturbances occur in one body system and other systems are unable to adjust; e.g., stroke, heart attack
- medical technology can be used to monitor body conditions and personal health factors
  - give examples of ways in which technology can be used to monitor critical life functions

Science 26

Skills (continued)

- analyze and assess personal health, fitness and lifestyle factors by identifying relationships, by considering alternatives and consequences, and by examining a variety of viewpoints
- make inferences regarding the impact of lifestyle decisions on level of personal health and fitness
- apply the results of investigation to personal situation, and develop consensus regarding appropriate strategies for monitoring and maintaining personal health.

Concepts

The student will be expected to demonstrate an understanding that:

- personal diet should include minimal amounts of certain foods in order to maintain health
  - describe the function of nutrients (i.e., carbohydrates, fats, proteins, vitamins, minerals) in the human body
  - identify foods/food groups that are a source of major nutrients, and those that add fibre content to diet
  - cite examples of good nutrition as defined in the *Canada Food Guide*
  - explain how diets that include excessive amounts of certain foods (e.g., diets high in cholesterol, fat, salt, sugar) may influence personal health
- much of our food, particularly processed food items, contain additives
  - identify and describe the functions of additives present in familiar processed foods
  - interpret label information on familiar processed foods, distinguishing between nutritional and non-nutritional ingredients
- drugs, alcohol and tobacco may affect nutritional requirements and cause related disease
  - describe how drugs, alcohol and tobacco can affect appetite, nutritional requirements and the functioning of body systems

Science 16

Concepts (continued)

  - describe how technology may assist in diagnosing/treating malfunctions within body systems
  - illustrate, through example, how science and technology work together to expand our knowledge of body systems
- relationships exist between the diagnosis, prevention and treatment of malfunctions within body systems
  - explain how lifestyle factors and decisions may affect the health of body systems
  - identify strategies for maintaining personal health through diet and physical exercise
- societal issues may arise from the use of technologies in preserving balance among systems of the human body
  - describe how technologies can be used to preserve the balance of life when one or more systems are in failure; e.g., organ transplants, life-support systems
  - identify societal issues that arise when technologies are used to preserve balance when a system is in temporary or permanent failure.

Science 26

Concepts (continued)

  - give examples of specific diseases related to drug, alcohol and tobacco abuse
- a relationship exists between caloric intake, energy output and body weight
  - compare daily caloric intake to calorie requirements suggested by personal data; e.g., body mass index, basal metabolic rate, activity level
  - describe strategies for maintaining or increasing/decreasing present body weight through caloric intake and energy output
- physical exercise can contribute to cardiovascular and respiratory health
  - explain how level of fitness (e.g., endurance, strength, flexibility) is influenced by physical activity
  - identify relationships between level of fitness and the functioning of cardiovascular/respiratory systems
- personal and societal factors can have both positive and negative effects on one's health and well-being
  - identify personal and social factors that influence attitudes and behaviours; e.g., needs, values, emotions, peers
  - explain how particular attitudes/ behaviours may involve varying degrees of risk to personal health and well-being
- interrelationships exist among lifestyle factors/choices (e.g., diet, exercise, substance use/abuse, stress) and personal health
  - identify lifestyle factors and choices that affect personal health; e.g., diet, physical activity, substance use/abuse, stress
  - infer the consequences of inappropriate nutrition, level of activity and weight on personal health; e.g., minor deficiencies/ imbalances, life threatening conditions
  - describe a personal action plan designed to improve one or more aspects of personal health and lifestyle.

USING MATERIALS AND PRODUCTS

This theme focuses attention on the composition and properties of materials and products used by students in their everyday lives. Students will be expected to develop strategies for:

- safe handling of potentially dangerous materials and situations encountered within the home and work environments
- selecting consumer products on the basis of their composition, properties and suitability for particular applications.

A major emphasis will be placed on developing an understanding of the processes used in conducting scientific inquiry. In Science 16 (Chemistry for the Consumer), students will carry out a series of controlled experiments to investigate the chemical properties and active ingredients of common household substances. In Science 26 (Materials We Use), students will carry out controlled experiments to investigate the composition and properties of a variety of natural and synthetic materials used at home and in work-related situations.

Specific learner expectations listed below are developmental through Science 16 and 26, and should be applied to progressively difficult and/or age-appropriate situations as students advance through senior high school. Learner expectations that extend across columns reflect the continuous process of attitude and skill development.

Specific Learner Expectations

Science 16	Science 26
Attitudes *The student will be expected to:*	**Attitudes** *The student will be expected to:*
• appreciate the relationship of science principles to the properties of common household substances	• value scientific principles and processes for their usefulness in providing an understanding of everyday phenomena
• appreciate the usefulness of measurement skills in real-life and work-related situations	
• develop an awareness of applications of technological products and processes within the household	• appreciate how technology may facilitate the solving of practical problems, and create new problems
• appreciate both the usefulness and potential hazards of common household materials	• display a respect for personal safety and the safety of others when handling potentially hazardous materials
• appreciate the contributions of science and technology to the development of a variety of materials and products that we depend upon and use each day.	
Skills *The student will be expected to demonstrate an ability to:*	**Skills** *The student will be expected to demonstrate an ability to:*
• conduct investigations that illustrate the properties of pure substances and solutions	• identify procedures for investigating the properties of familiar natural and synthetic materials

Science 16	Science 26
Skills (continued)	**Skills** (continued)
• design experiments, through class discussion, that illustrate – factors affecting solubility – the differences between temporary and permanent suspensions – the behaviour of acid and base substances	• design experiments that illustrate – corrosive reactions among familiar substances/products – the insulation values of familiar fibres – the biodegradability of familiar materials/ projects
• use basic apparatus and equipment when conducting experiments	• effectively use apparatus and equipment when conducting experiments
• ask questions designed to guide observations	• make qualitative and quantitative observations
• identify similarities and differences in the properties of substances and solutions investigated, and apply this information by explaining how selected chemical products and reactions are used in performing routine tasks; e.g., cooking, cleaning	• identify patterns and relationships in the behaviour of natural and synthetic materials, and generalize data gathered so as to infer applications of particular types of consumer products
• predict heat exchange in practical situations, and use appropriate procedures for protecting living organisms and other materials from excessive heat transfer	
• read product labels in order to determine the composition and intended use of familiar household products	• read product labels and consumer reports in order to determine the composition and intended use of products found at home and at work
• apply appropriate techniques for identifying acids and bases	• develop and apply appropriate techniques for identifying acids, bases and other hazardous materials
• use safe procedures for handling and storing potentially dangerous substances.	
Concepts *The student will be expected to demonstrate an understanding that:*	**Concepts** *The student will be expected to demonstrate an understanding that:*
• the properties of household solutions are different from those of pure substances – describe the properties of solutions and the properties of pure substances – distinguish between familiar household substances that are pure and those that are solutions, giving examples of each	• models and other conceptual inventions are useful in explaining the composition and behaviour of matter – illustrate, through the use of models, how atoms and molecules represent structural units of matter – relate the behaviour of atoms and molecules in familiar substances to the Kinetic Molecular Theory – interpret symbols/formulas that represent the most common elements and simple compounds familiar to the student

Science 16

Concepts (continued)

- permanent suspensions have useful properties and a variety of applications in the home
  - describe the properties of permanent suspensions
  - identify examples of familiar permanent suspensions used in the home
  - explain the importance of permanent suspensions by relating the consequences of separation to common household products and situations
- acids and bases have useful properties and a variety of applications in the home
  - describe how acids and bases can be identified according to their natural properties
  - identify examples of familiar acids and bases used in the home
  - illustrate how acids and bases react with other household substances in both useful and potentially dangerous ways
- solubility varies with temperature
  - demonstrate how temperature change affects the solubility of one familiar household solute
  - cite real-life situations in which temperature change affects solubility
  - explain the concept of unsaturated, saturated and supersaturated solutions
- many chemical reactions may require or emit energy in the form of heat
  - distinguish between types of household reactions that require heat energy and those that produce heat energy
  - explain the usefulness of household reactions that require and produce heat energy
- heat flows from areas of high temperature to areas of lower temperature
  - compare heat exchange by conduction, convection and radiation in different mediums
  - determine the mode of heat transfer involved in familiar processes used at home and at work

Science 26

Concepts (continued)

- the properties of the materials and products we use are determined by their composition
  - describe the composition of two or more familiar materials in terms of their elements, atoms, molecules and compounds
  - relate the properties of two or more familiar materials to their composition
- materials and products are derived from both natural and synthetic sources
  - identify products in everyday use that are derived from both natural and synthetic sources
  - describe the industrial process involved in the manufacture of at least one natural product and at least one synthetic product
- the properties of materials determine their suitability for particular applications
  - describe the properties of familiar materials used at home and in work-related situations; e.g., metals/alloys, wood/paper products, fibres/fabrics, plastics/polymers, composite materials
  - cite the advantages and/or disadvantages of familiar materials, relative to their suitability for particular applications
- our use of natural and synthetic materials affect both environment and resources
  - cite advantages and/or disadvantages associated with the use of a familiar natural and synthetic product, relative to the industrial processing of resources to form the product, and the effect of the product's disposal on the environment
  - infer the need for biodegradable products and recyclable products
- the process of biodegradation reduces the impact of some products on the environment
  - explain the process of biodegradation
  - describe how non-biodegradable materials may harm the environment
  - distinguish between familiar materials/ products that are biodegradable and non-biodegradable

Science 16

Concepts (continued)

- handling, storing and using potentially hazardous chemical products require knowledge and care
  - identify common substances that have safety labelling
  - explain why it is important to read instructions for safe handling
  - cite the potential dangers of mixing certain household products
  - describe recovery techniques for common errors in handling.

Science 26

Concepts (continued)

- technological products and processes develop in response to societal needs, and are often accepted and used before the full extent of benefits/problems resulting from their use can be known
  - describe a situation in which science and technology have assisted in solving a practical problem through the development of a new material
  - identify a current issue/problem in society arising from the application of a technological product or process.

TECHNOLOGY AT WORK

This theme will provide opportunities for students to develop an understanding of scientific principles governing the operation of familiar technological devices and systems, as well as the process by which these technologies are developed. Students will be expected to examine, test and evaluate the operation of simple technological devices, and also design and construct devices that are intended to meet specific needs.

A major emphasis will be placed on developing a process for solving practical problems of a technological nature through hands-on experience. In Science 16 (Using Systems and Technologies), students will investigate simple technological devices and systems frequently used at home and in the workplace. In Science 26 (Technology in Transportation), students will apply previously developed knowledge of technological systems as they investigate the functioning of different subsystems in an automobile, as well as issues related to automobile safety and driver protection.

Specific learner expectations listed below are developmental through Science 16 and 26, and should be applied to progressively difficult and/or age-appropriate situations as students advance through senior high school. Learner expectations that extend across columns reflect the continuous process of attitude and skill development.

Specific Learner Expectations

Science 16

Attitudes

The student will be expected to:

- appreciate that science and technology have application in practical everyday situations

Science 26

Attitudes

The student will be expected to:

- appreciate that ethical dilemmas may arise from applications of science and technology

- develop confidence in personal ability to understand and solve practical problems through applications of science and technology

- appreciate that in solving problems scientifically, new technologies develop

- develop an awareness that science may involve technology and technology may involve science

Science 16	Science 26
Attitudes (continued)	**Attitudes** (continued)
• display a concern for safety when operating familiar technological devices and systems	• accept the need for rules and regulations governing the use of particular technologies
• appreciate the relationships among science, technology and society.	
Skills *The student will be expected to demonstrate an ability to:*	**Skills** *The student will be expected to demonstrate an ability to:*
• observe, at first hand, the operation of <u>one</u> or more familiar technological devices or systems, identifying component parts and scientific principles that are used	• analyze the operation of <u>one</u> or more subsystems in an automobile (e.g., electrical system, cooling system, fuel system, lubrication system, tire/braking system),interpreting relationships among component parts and scientific principles being utilized
• prepare drawings based on observations that illustrate relationships among component parts of a technological device or system	• prepare systems diagrams that illustrate how component parts and/or subsystems within an automobile work together in accomplishing a task
• formulate and test hypotheses regarding the performance of <u>one</u> or more technological devices or systems – suggest basic principles governing its/their operation and use – predict malfunctions and subsequent maintenance procedures that are required	• evaluate the performance of <u>one</u> or more technological devices/systems in an automobile – infer potential malfunctions and appropriate maintenance/repair procedures – suggest ways to improve efficiency of design and/or operation
• use a problem-solving strategy to design and create a simple technological device or process – identify a current need or problem not satisfied by technology – consider alternative approaches/designs to deal with the problem – select an appropriate design and safely create the technological device or process – test and troubleshoot the technological device or process – evaluate the process used and/or the product's performance and design	
• draw conclusions regarding the needs satisfied and problems solved by specific technologies.	• make inferences regarding the impact of technological development on society, and the relationship between consumers' expectations and producers' responsibilities.
Concepts *The student will be expected to demonstrate an understanding that:*	**Concepts** *The student will be expected to demonstrate an understanding that:*
• technology may facilitate the solving of practical problems through application of scientific knowledge	• the automobile is a technological system consisting of a number of subsystems that work together

Science 16

Concepts (continued)

  - identify a variety of human needs/wants and the technological products and/or processes developed to meet them
  - illustrate, with at least one example, the application of scientific knowledge in solving a practical problem

- basic scientific principles are associated with the functioning of technological devices
  - identify and explain relevant scientific facts, laws and theories related to two or more of the topics suggested below:
    - machines
    - electricity and/or electronics
    - heat and thermal systems
    - fluid systems
  - apply scientific principles that are investigated in explaining the operation of familiar technological devices
- many technological systems consist of combinations of subsystems that work together in accomplishing a particular task
  - give examples of technological systems that consist of combinations of mechanical, electrical, thermal and/or fluid subsystems
  - identify subsystems, component parts and energy flow within at least one technological system
- science can be used to advance technology and technology can be used to advance science
  - give examples of situations where science leads to advances in technology
  - give examples of situations where technology leads to advances in science
- new and emerging technological products/ processes often reflect current needs and wants in society
  - identify a recent technology, the need it was intended to satisfy, and the process by which it was developed
  - infer the impact of this technology on individuals and society
- products of technology are often used by society before the full extent of benefits/ problems resulting from their use can be known.

Science 26

Concepts (continued)

  - describe the basic function of different subsystems in an automobile, including the electrical system, cooling system, fuel system, lubrication system and tire/ braking system
  - illustrate how subsystems in an automobile work together by tracing energy flow/ transformation through two or more subsystems

- basic scientific principles are associated with the functioning of subsystems in an automobile
  - explain the operation of one or more subsystems in an automobile, citing relevant scientific facts, laws and theories
- simple maintenance procedures contribute to the efficient performance and general safety of an automobile
  - identify subsystems/component parts that require routine maintenance checks
  - describe common malfunctions that indicate service and/or repairs are required; e.g., muffler noise, steering problems
  - outline procedures to follow in "winterizing" an automobile
- the nature of injuries sustained in an automobile accident can be anticipated by considering the effects of first and second collisions
  - relate Newton's laws of motion to the effects of first and second collisions in automobile accidents
  - outline energy conversions in an automobile collision, and relate energy transferred in a collision to the direction of moving objects involved
- technology has contributed to safe travel through the development of highway and automobile safety features
  - explain principles that govern the operation of automobile safety technologies, including safety belt systems, padded dashboards and air bag systems
  - describe other features of automobile design and highway design that contribute to safe travel

Science 16

Concepts (continued)

Science 26

Concepts (continued)

- political, ethical and economic perspectives often interact with science and technology, influencing choices and decisions that are made about safe travel
  - summarize recent statistical data that relates risk of automobile injury to travel speed, alcohol consumption and the use/non-use of seat belts
  - identify local laws, safety standards and licensing requirements that are designed to reduce risk of automobile injury
  - identify other perspectives (e.g., economic, environmental) that influence the development of automobile technologies and safety features.

UNDERSTANDING OUR ENVIRONMENT

Human populations have had considerable impact upon the environment and our natural resources. As members of society, we must ensure that science and technology are used in ways that will minimize the impact of an increasing population on our fragile biosphere. This theme will enable students to:

- identify an environmental issue that arises from the local use of natural resources
- investigate the issue by considering a variety of related factors
- suggest an action plan to deal with the environmental issue.

A major emphasis will be placed on developing a process for building consensus on environmental issues through research, discussion and debate. In Science 16 (Caring for Environment and Resources), investigations will focus attention on ecology and the biosphere. In Science 26 (Energy and the Environment), students will apply previously developed knowledge as they consider the effects of alternative energy-use practices on the environment.

Specific learner expectations listed below are developmental through Science 16–26, and should be applied to progressively difficult and/or age-appropriate situations as students advance through senior high school. Learner expectations that extend across levels reflect the continuous process of attitude and skill development.

Specific Learner Expectations

Science 16

Attitudes

The student will be expected to:

- appreciate the fragility of the biosphere

Science 26

Attitudes

The student will be expected to:

- develop an aesthetic appreciation of the environment

Science 16	Science 26
Attitudes (continued)	**Attitudes** (continued)
• appreciate the interdependence of self with other living forms and with the environment	• realize our inability to fully anticipate the environmental effects of human activities
• appreciate that environmental issues involve significant relationships among science, technology and society	
• appreciate that environmental knowledge and understanding are necessary for individuals to think critically about related issues	• appreciate the need to assess the accuracy and reliability of environmental information acquired
• develop a sense of personal responsibility in relation to conservation of natural resources and stewardship of the planet.	• appreciate that the collective action of individuals can have significant impact on the responsible use, conservation and maintenance of the environment.
Skills *The student will be expected to demonstrate an ability to:*	**Skills** *The student will be expected to demonstrate an ability to:*
• identify an environmental issue related to the local use of natural resources	• identify an environmental issue related to the local use of energy resources
• collect data related to the issue through observation, interview and/or research	• collect data related to the issue by using a variety of information-gathering techniques
• conduct an investigation that illustrates how particular practices are related to the issue and influence environmental quality	• plan, design and conduct an investigation to test a hypothesis regarding the issue
• analyze and assess data by identifying patterns and relationships and by considering consequences	• analyze and assess data by identifying patterns and relationships, by considering alternatives and consequences, by examining a variety of viewpoints, and by judging the reliability/validity of information gathered
• communicate the results of investigation verbally, through the use of models and diagrams, and/or through written expression	
• take an informed position on the issue, identifying strategies that may be used to deal with the situation.	• take an informed position on the issue, justify strategies that are advocated, and develop consensus within a group.
Concepts *The student will be expected to demonstrate an understanding that:*	**Concepts** *The student will be expected to demonstrate an understanding that:*
• the biosphere is a thin layer on the surface of the earth, able to support life – identify components of the biosphere that provide the essentials of life – relate components of the biosphere to their importance in sustaining life	• different forms of energy are used at home and in work-related situations – identify major forms of energy (e.g., mechanical, light, sound, heat, electrical, chemical) and explain their applications in familiar technologies

Science 16

Concepts (continued)

- a continuous supply of solar energy is essential to life
  - illustrate, with at least one example, how living things acquire their energy either directly or indirectly from the sun
  - explain how photosynthesis and respiration are involved in energy conversions necessary for life
  - trace energy transfer from one feeding level to another within a food pyramid, and describe how energy is lost at each transfer
- life depends upon recycling processes
  - illustrate, with at least one example, how biochemical cycles provide a continuous supply of materials necessary for life
  - explain how materials are decomposed through the recycling process
  - explain how biodegradable materials reduce the impact of man-made products on the environment
- living organisms interact with each other and with the physical environment
  - identify physical factors that influence local populations
  - describe how interactions among organisms affect populations
  - illustrate, with at least one example, the impact of living organisms on the local environment
- individuals and society influence the quality of the environment
  - identify familiar technological products and processes that produce materials that are not readily decomposed
  - give at least one example of a local land-use practice resulting in major changes to the environment
  - describe the relationship between densely populated areas and the production of wastes that exceed the environment's capacity to recycle
  - give examples of how technological developments and societal actions may improve the quality of the local environment

Science 26

Concepts (continued)

  - distinguish between potential energy (i.e., stored energy) and kinetic energy (i.e., energy of movement) in practical situations
- there are renewable and non-renewable sources of energy
  - give examples of renewable energy sources (e.g., solar, wind, geothermal) and their value in providing for energy requirements
  - give examples of non-renewable energy sources (e.g., fossil fuels) and societal issues arising from their use
- energy systems have input, conversion and output components
  - explain how living organisms (e.g., plants, the human body) are energy systems having input, conversion and output components
  - trace energy flow in a simple technological system, identifying input, conversion and output components
- the total energy of a system is conserved
  - illustrate, by referring to a simple energy system model, how energy is neither created nor lost, but converted from one form to another in energy systems
  - construct energy chains that trace forms of energy used in familiar technologies back to other sources
- energy efficiency ratings describe the portion of input energy that is converted to useful energy
  - compare and contrast two simple energy systems in terms of their overall efficiency
  - suggest ways of improving the efficiency rating of a familiar energy system through modifications in design
- consumption of electrical energy in the home can be analyzed and monitored
  - identify major components of electrical energy systems used in the home; i.e., energy source, distribution system, conversion and output components

Science 16

Concepts (continued)

- developments in science and technology may have unforeseen consequences on society and the environment
  - give examples of how science and technology develop in response to societal needs
  - explain how scientific/technological developments, while meeting human wants and needs, may create or intensify environmental problems; e.g., pollution
  - identify examples of the unforeseen consequences of science and technology in the local area
  - evaluate the societal impact of at least one development in science and technology
- individuals and society can become involved in the resolution of ecological problems that arise
  - identify ways that an individual can provide a degree of direction and control over local use of environment and resources; e.g., personal habits, lobby groups
  - identify ways that society can influence science/technology in resolving ecological problems; e.g., voting, legislation, provision of fiscal and manpower resources.

Science 26

Concepts (continued)

  - determine the amount and cost of electrical energy consumed by familiar appliances/technologies in the home
  - interpret electrical utility meters and account statements
  - describe appropriate strategies for reducing consumption of electrical energy
- energy conservation involves the interaction of economic, political and ethical perspectives with science and technology
  - explain how energy conservation practices must include consideration of a number of factors, including the availability/supply of energy resources; the effects of alternative forms of energy on the environment; the cost of producing different forms of energy; and the efficient use of energy at local, national and international levels
  - describe recent contributions of science and technology in the field of energy conservation.